



Briefing on:

Operational CFSv2

Atlantic Ocean Cold Bias Problem

The EMC Climate Team

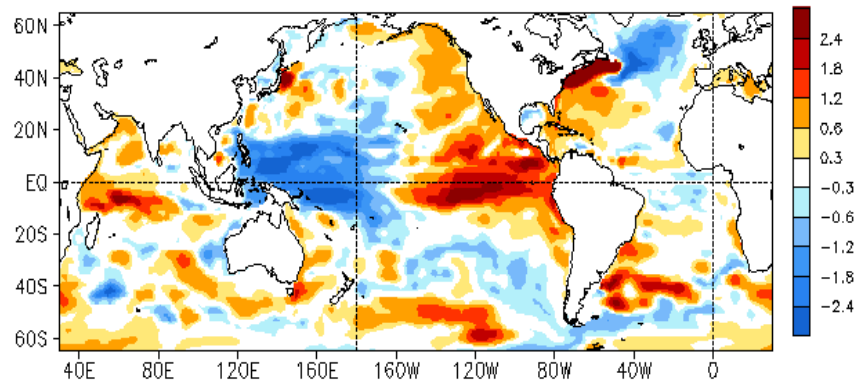


Operational CFSv2 Atlantic Ocean Cold Bias Problem

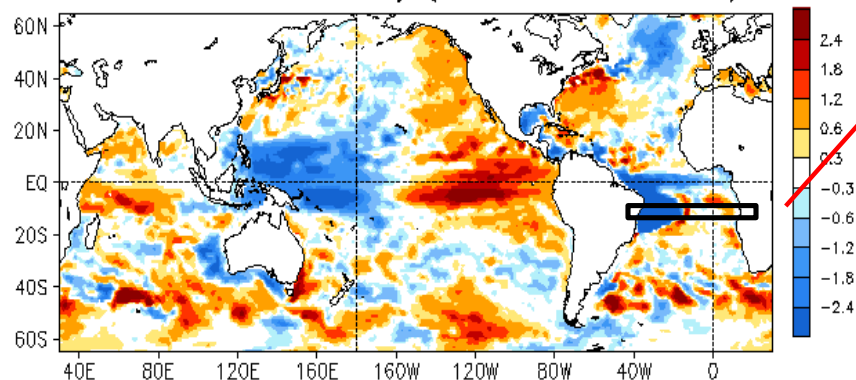
- A large cold bias emerged in the ocean initial conditions along the equator in the spring of 2015, and grew to include the South Atlantic in the summer of 2015. These cold biases had translated into cold biases in the same regions in CFSv2 forecasts.
- The presence of these large cold biases was noted by several external and internal stakeholders. The ENSO forecasts from the CFSv2 from December 2015 showed unusual behavior, in that the El-Nino event did not transition to neutral, but rather experienced a double-dip El-Nino, which is unprecedented in the modern era.

Recent CFSv2 Cold Biases in Tropical South Atlantic

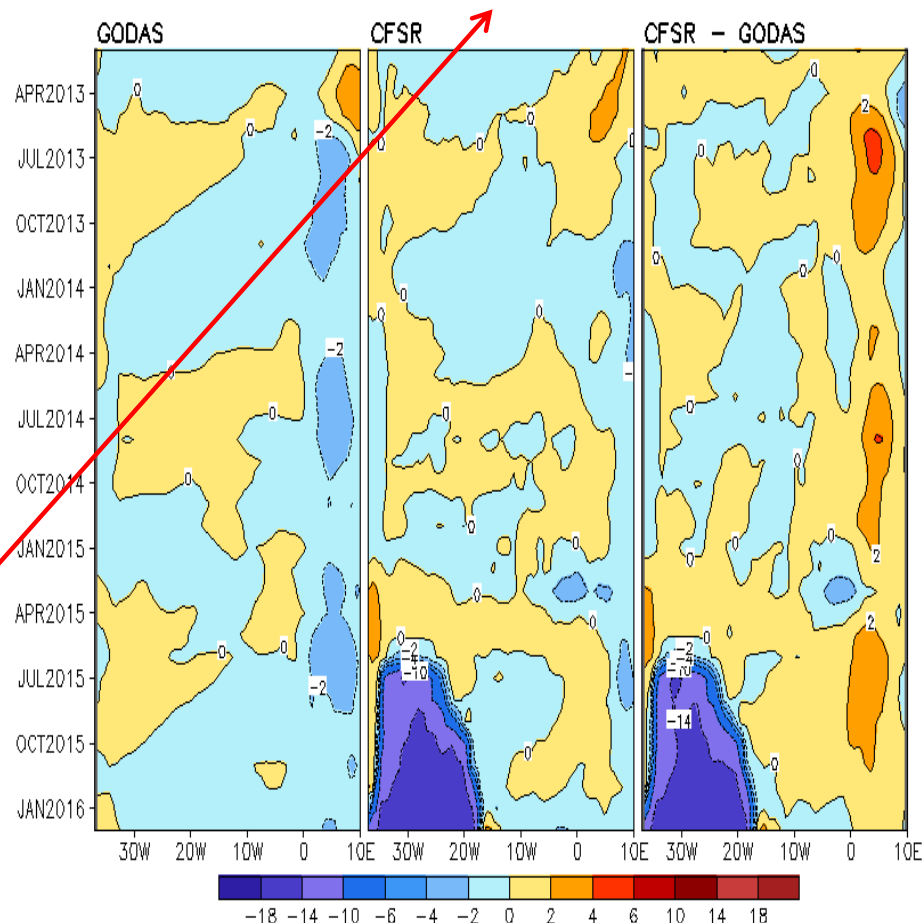
FEB 2016 HC300 Anomaly ($^{\circ}\text{C}$, Clim. 1999–2010): GODAS



FEB 2016 HC300 Anomaly ($^{\circ}\text{C}$, Clim. 1999–2010): CFSR

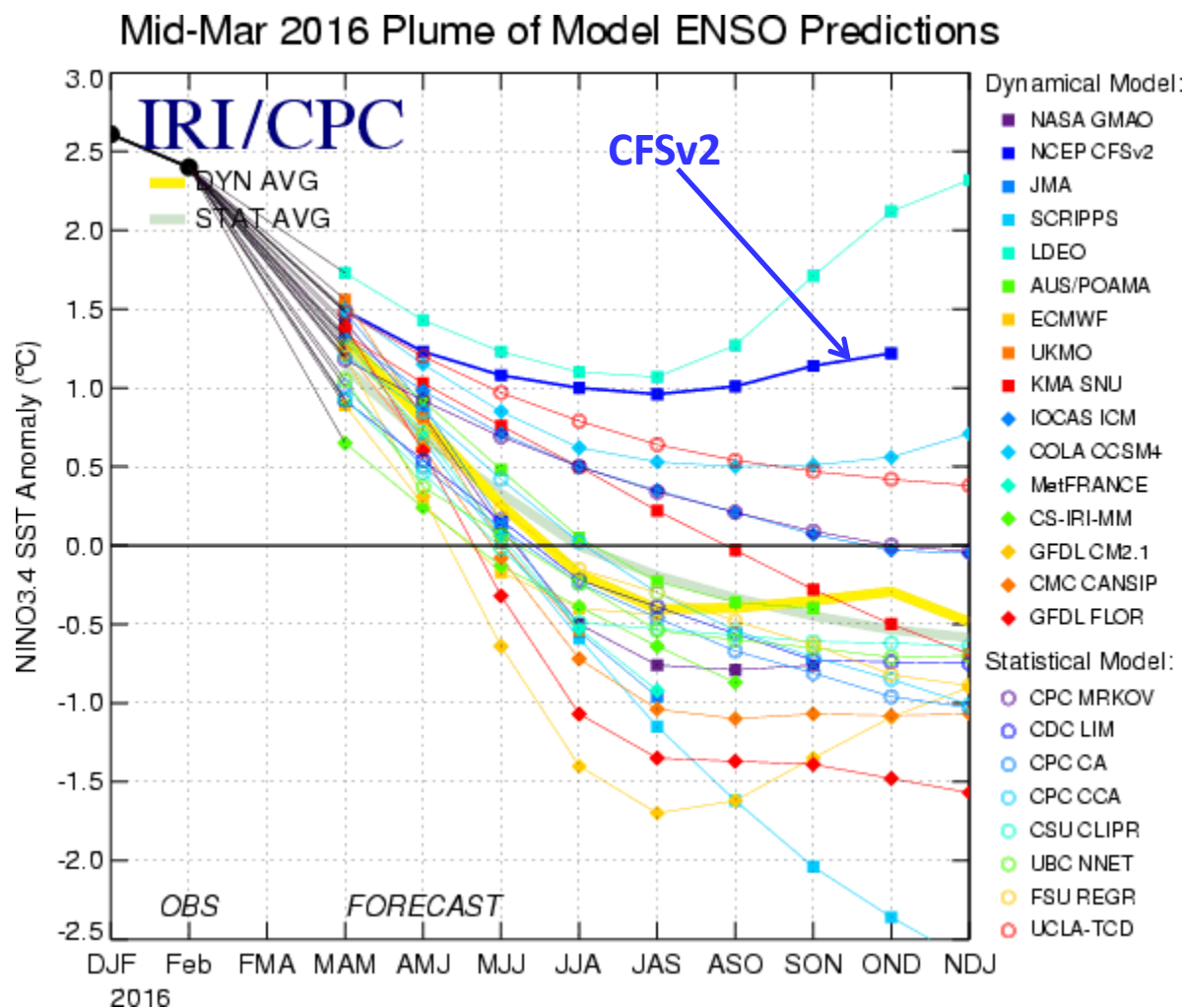


Temperature Anomaly at $z=55\text{m}$ in 9°S – 11°S ($^{\circ}\text{C}$, Clim. 1999–2010)



- A cold bias emerged around 10S in the South Atlantic around **Jul 2015** and enhanced quickly with time.
- It reached **-18 degree at 55m depth** since Oct 2015.

Impact on ENSO Evolution





Mitigation Strategy

- 1) The first fix was for NCO to immediately “re-initialize” the ocean initial conditions in the operational CFSv2 from an offline GODAS, and continue to “re-initialize” if there is a re-emergence of the problem on an occasional basis (~once a week or less), as is done occasionally for operational RTOFS models.
- 2) If “re-initialization” has to be done on a more frequent basis, then explore the possibility of NCO obtaining the reinitialized files for every cycle, in a manner similar to ingesting the CPC precipitation analysis for the operational GLDAS (land-surface) in CFSv2.
- 3) A longer-term fix involving a scientific/technical solution that will take careful thought and potentially significant testing, before it can be operationalized in a 3-6 month time frame.



Preliminary Results

The EMC Climate Team tested the re-initialization strategy for 4 initial months (December 2015 through March 2016).

Results are shown in next 4 slides.

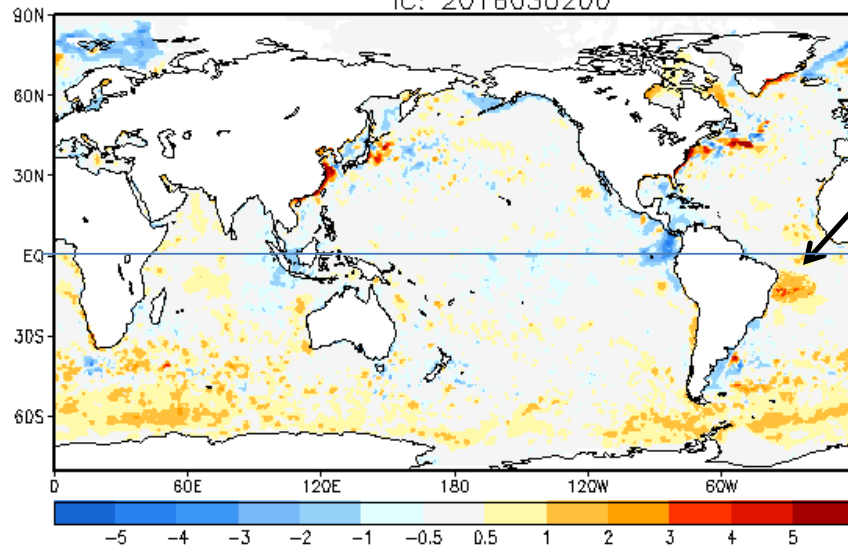
Summary:

- No Atlantic cold bias in the initial states as compared to current operational CFSv2.
- Evolution of the current El Nino event into La Nina during the next winter (2016-2017) in the Nino3.4 SST plumes.

CFSv2 : 1-8 March 2016 Initial conditions

OCN -5m Temp Analysis. Exper minus Oper

IC: 2016030200

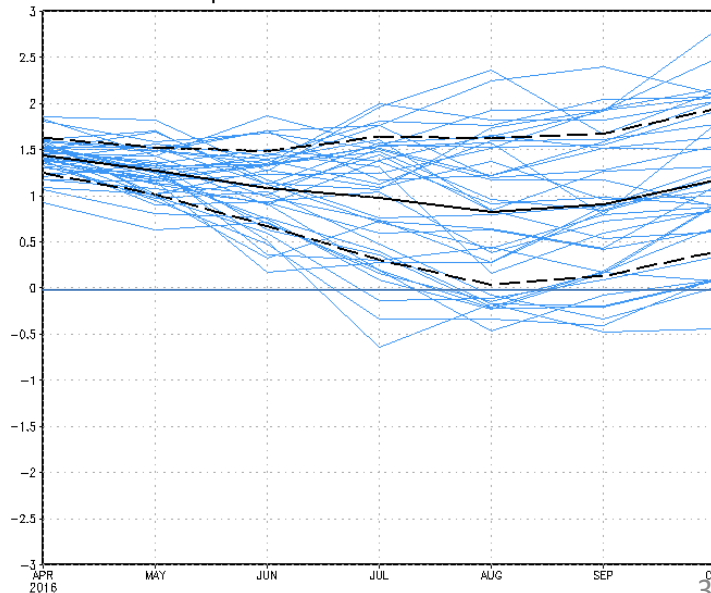


Noticeably warmer,
Elimination of the cold
bias in all 4 initial months
of testing.
Also, CFSv2 is not an
outlier as shown on slide 5
for the ENSO evolution.

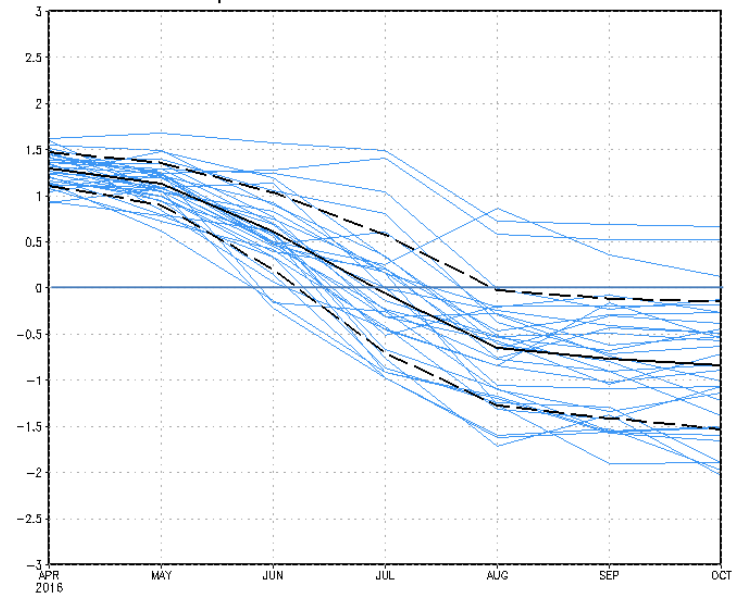
Operational

Experimental

Nino 3.4 plume. MDL 1. Mean \pm 1 Std Dev



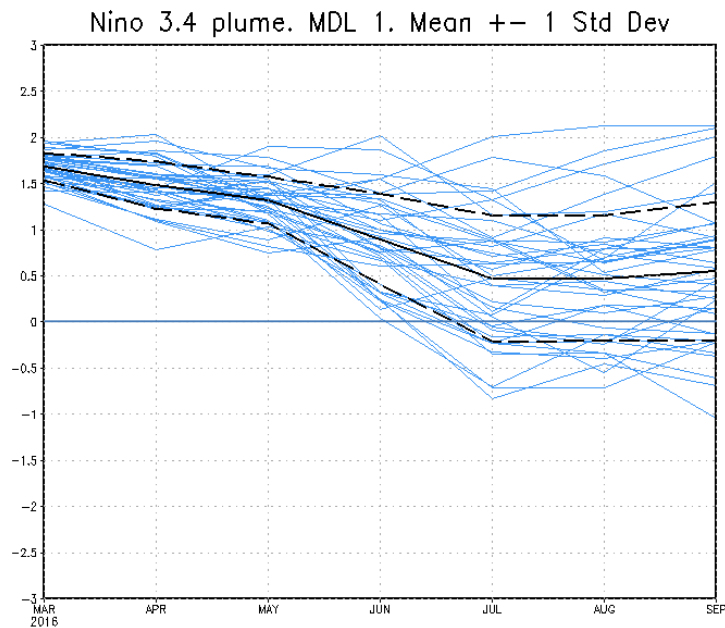
Nino 3.4 plume. MDL 1. Mean \pm 1 Std Dev



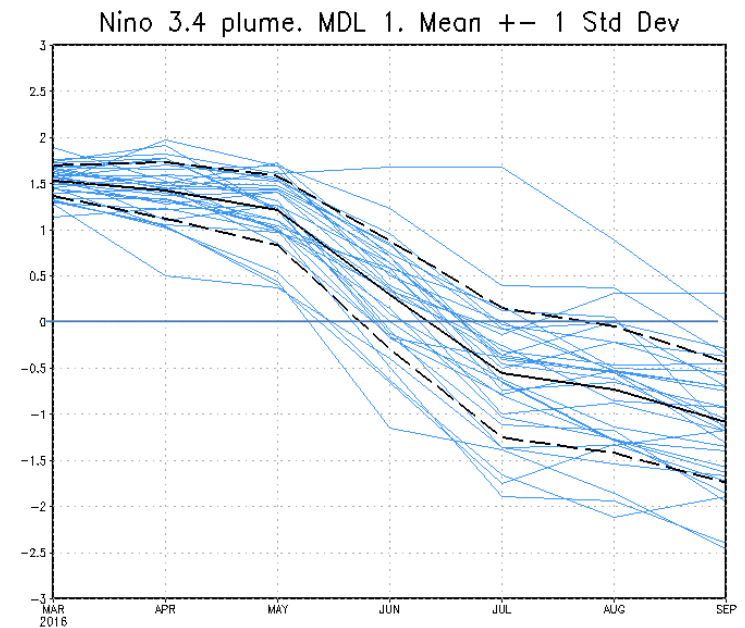
30 March 2016

CFSv2: 1-8 February 2016 Initial conditions

Operational

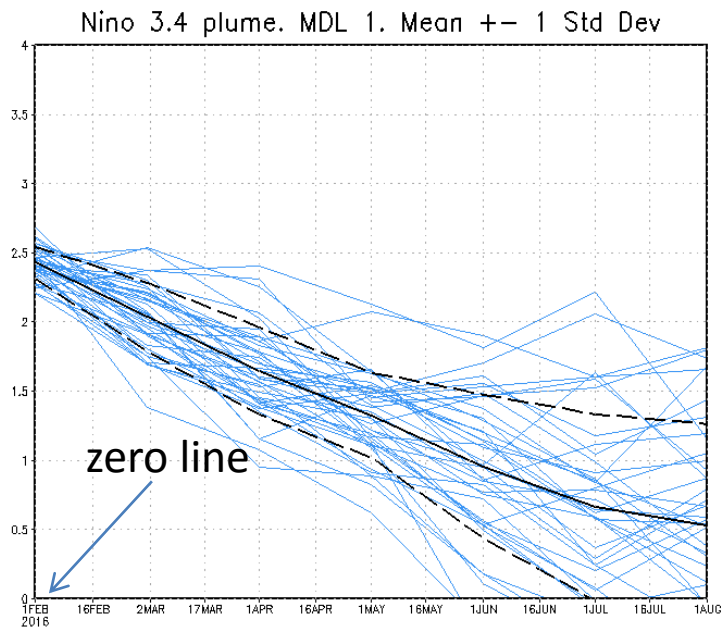


Experimental

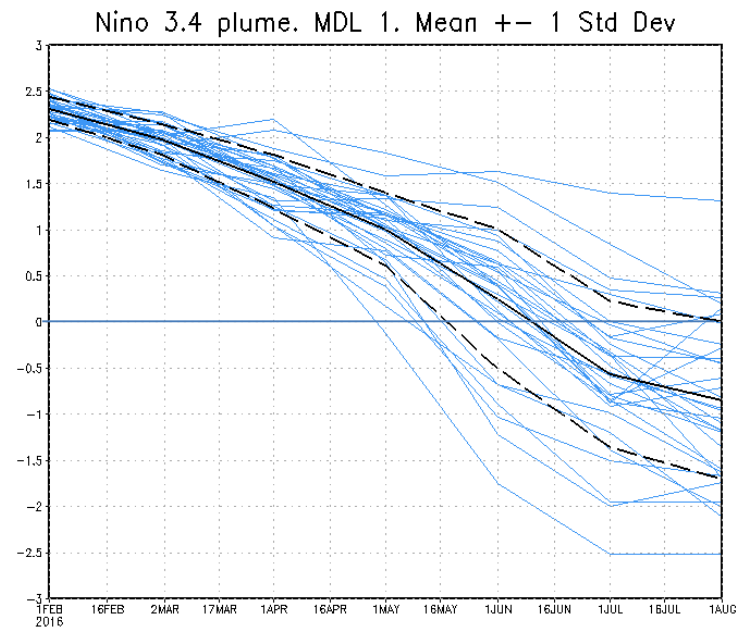


CFSv2: 1-8 January 2016 Initial conditions

Operational

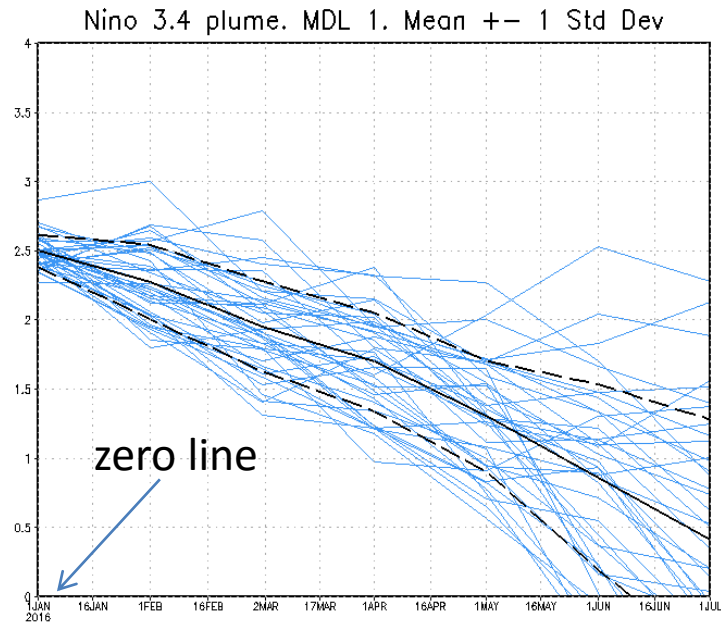


Experimental

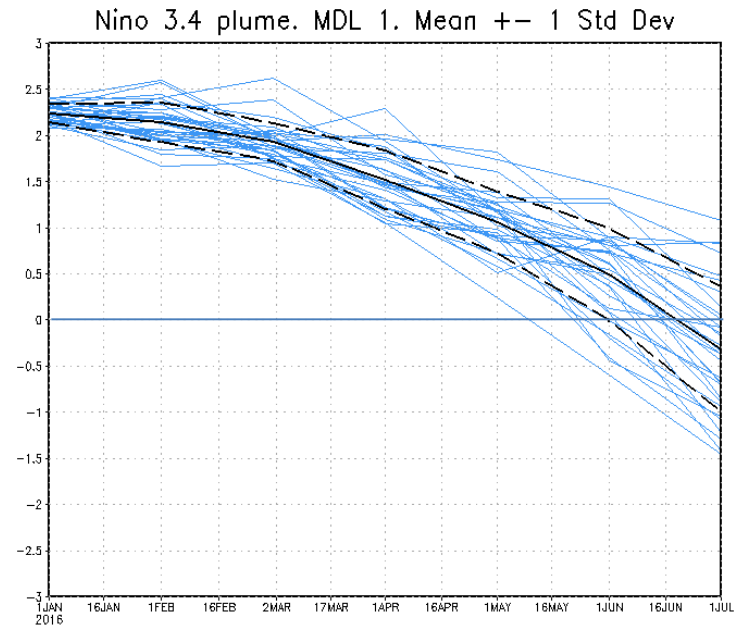


CFSv2: 1-8 December 2015 Initial conditions

Operational



Experimental



NOUS41 KWBC XXXXXX
PNSWSH

Technical Implementation Notice XX-XX

National Weather Service Headquarters Washington DC
XXX PM EDT Fri Mar 25, 2016

To: Subscribers:
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 -Emergency Managers Weather Information Network
 -NOAAPORT
 -Other NWS Partners, Users and Employees

From: Tim McClung
 Chief Operating Officer
 NWS Office of Science and Technology Integration

Subject: **Reset of ocean initial conditions in the operational Climate Forecast System version 2 (CFSv2) to remove Atlantic Ocean cold bias**

Beginning with the **0600 Coordinated Universal Time (UTC) model run on Monday, March 28, 2016**, the National Centers for Environmental Prediction (NCEP) Central Operations will implement a fix to the Global Ocean Data Assimilation System used in the Climate Forecast System (CFSv2). This fix is expected to remove an erroneous cold anomaly in the equatorial and South Atlantic Ocean temperature.



Operational Implementation of the fix

However, due to a glitch in the implementation on Monday March 28,

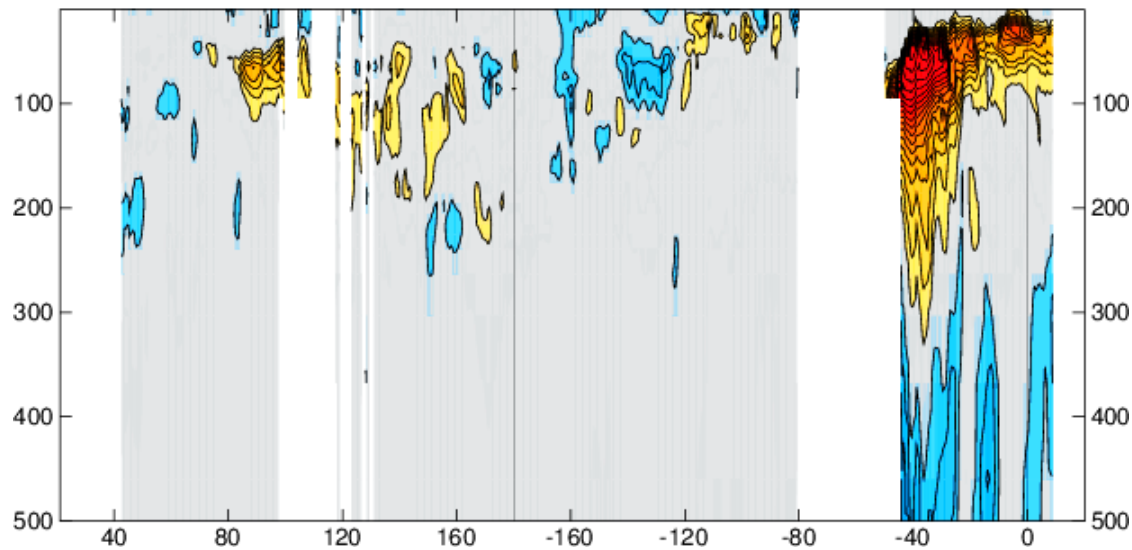
Beginning with the 0600 UTC model run on Tuesday, March 29, 2016, the National Centers for Environmental Prediction (NCEP) Central Operations implemented a fix to the Global Ocean Data Assimilation System used in the Climate Forecast System (CFSv2).

This fix has removed an erroneous cold anomaly in the equatorial and South Atlantic Ocean temperature.

CFS analysis Equatorial section March 29, 2016

Temperature

diff: 06Z - 00Z

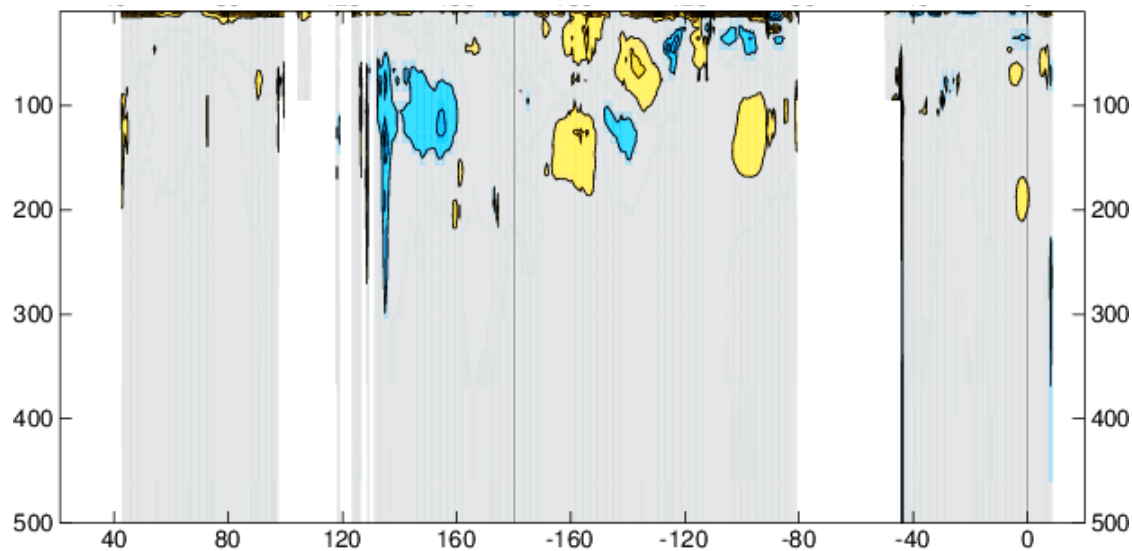


06Z transplanted
GODAS analysis
minus
00Z CFS analysis

c.i. = 1.0°C

Temperature

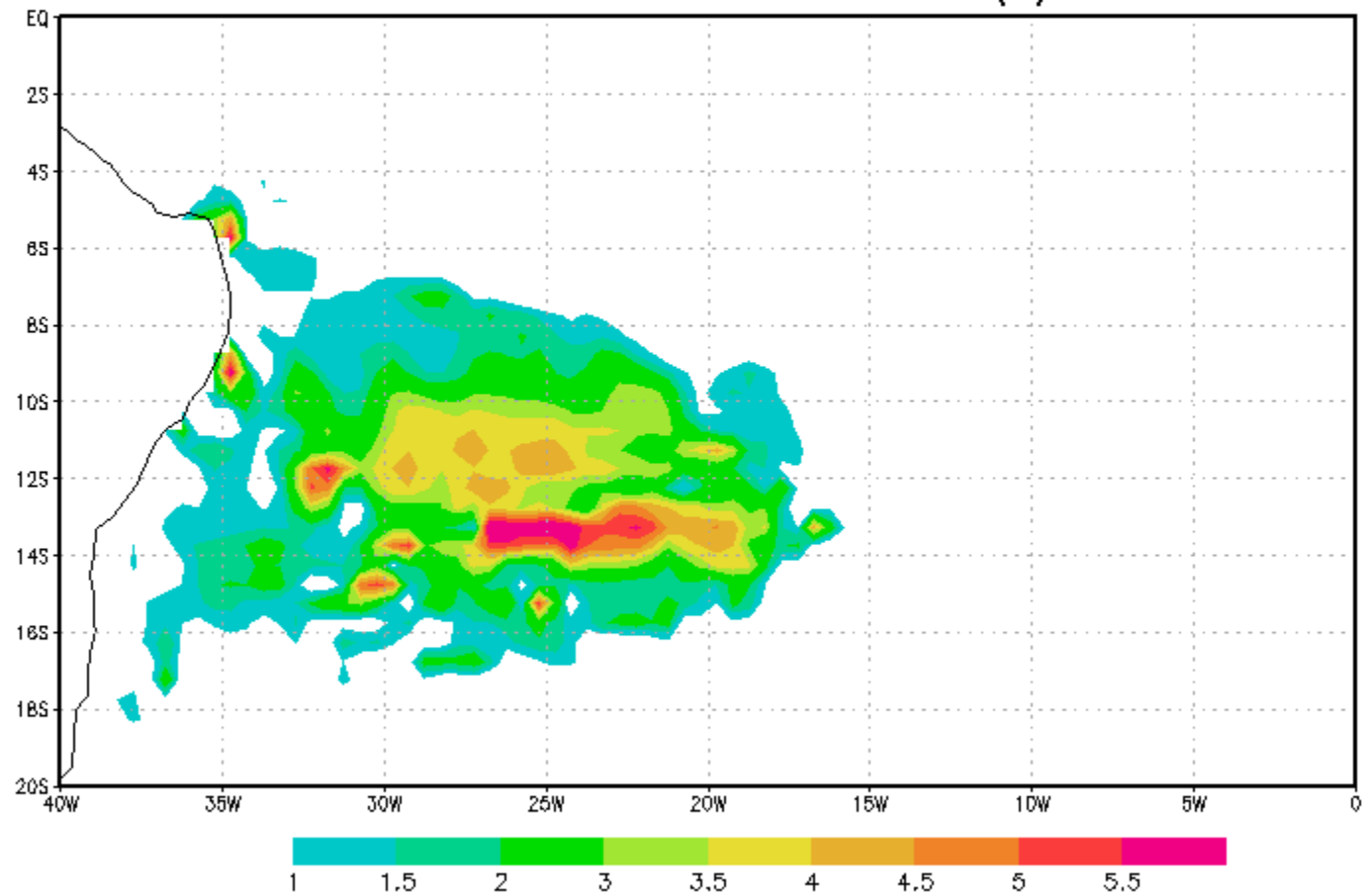
diff: 12Z - 06Z



12Z CFS analysis
minus
06Z transplanted
GODAS analysis

c.i. = 0.1°C

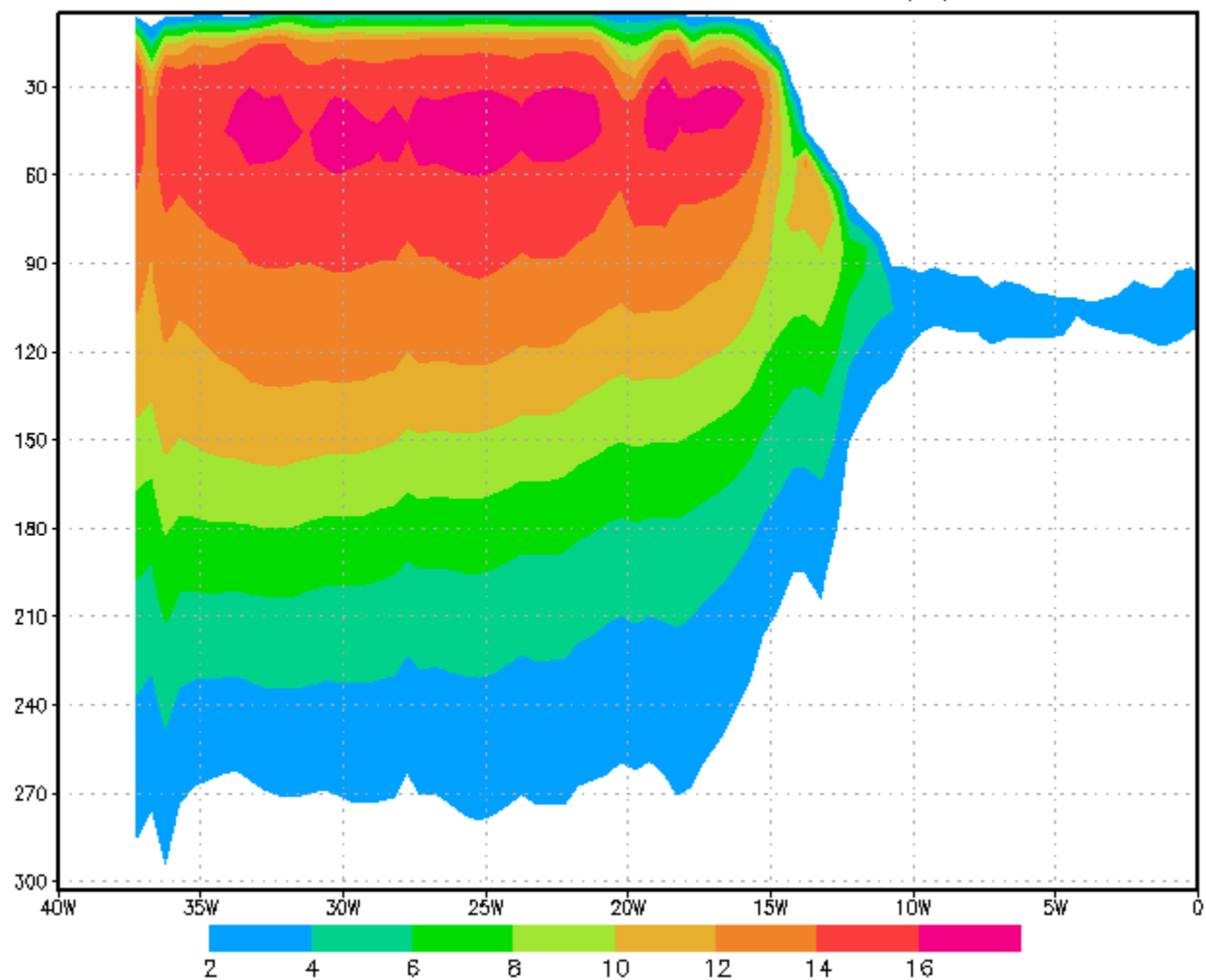
Mar29-Mar28 12Z 6-hr fcst Potdsl (K) at 5m



GrADS: COLA/IGES

2016-03-29-15:00

Mar29-Mar28 12Z 6-hr fcast Potdsl (K) at 12S

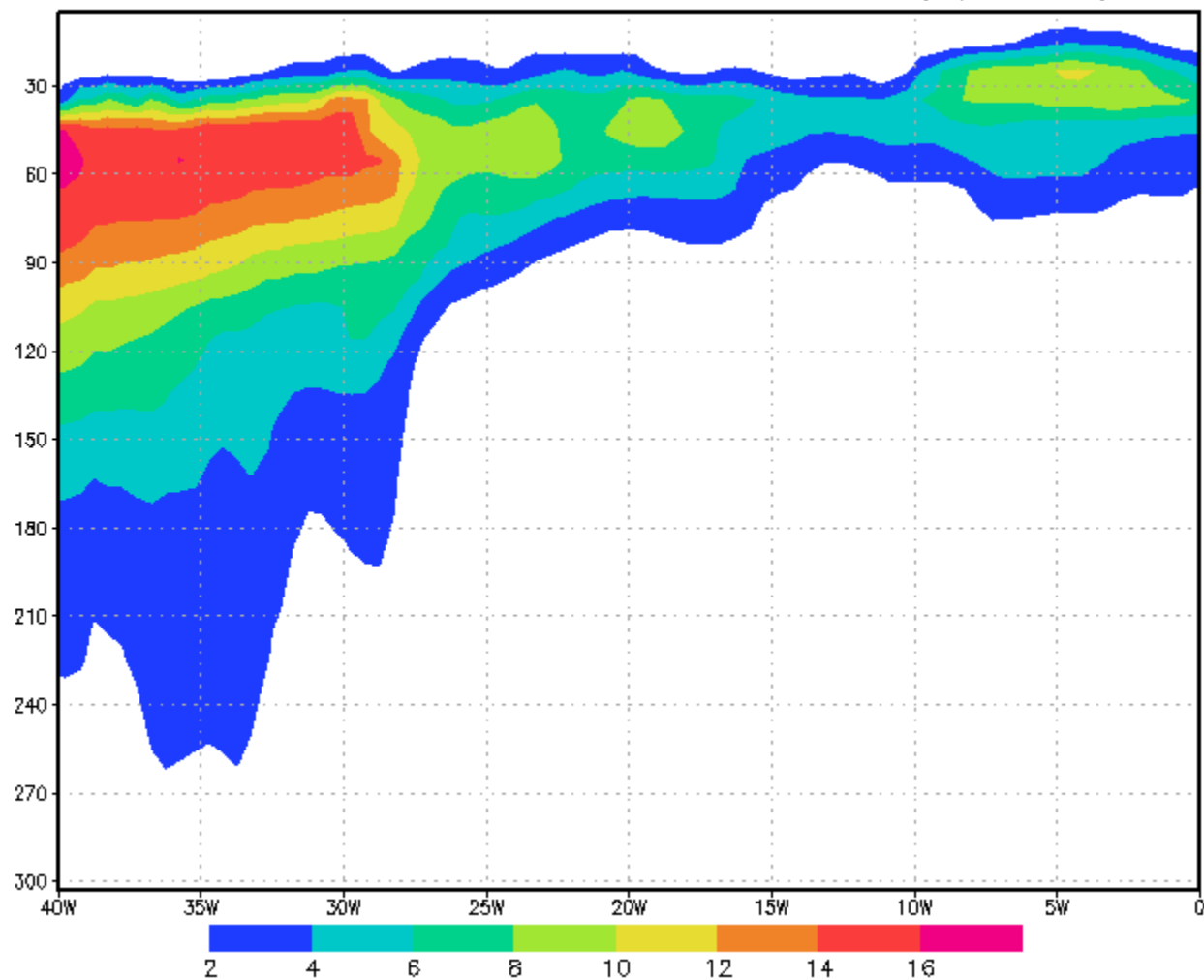


GrADS: COLA/IGES

2016-03-29-15:02

30 March 2016

Mar29-Mar28 12Z 6-hr fcst Potdsl (K) at Eq



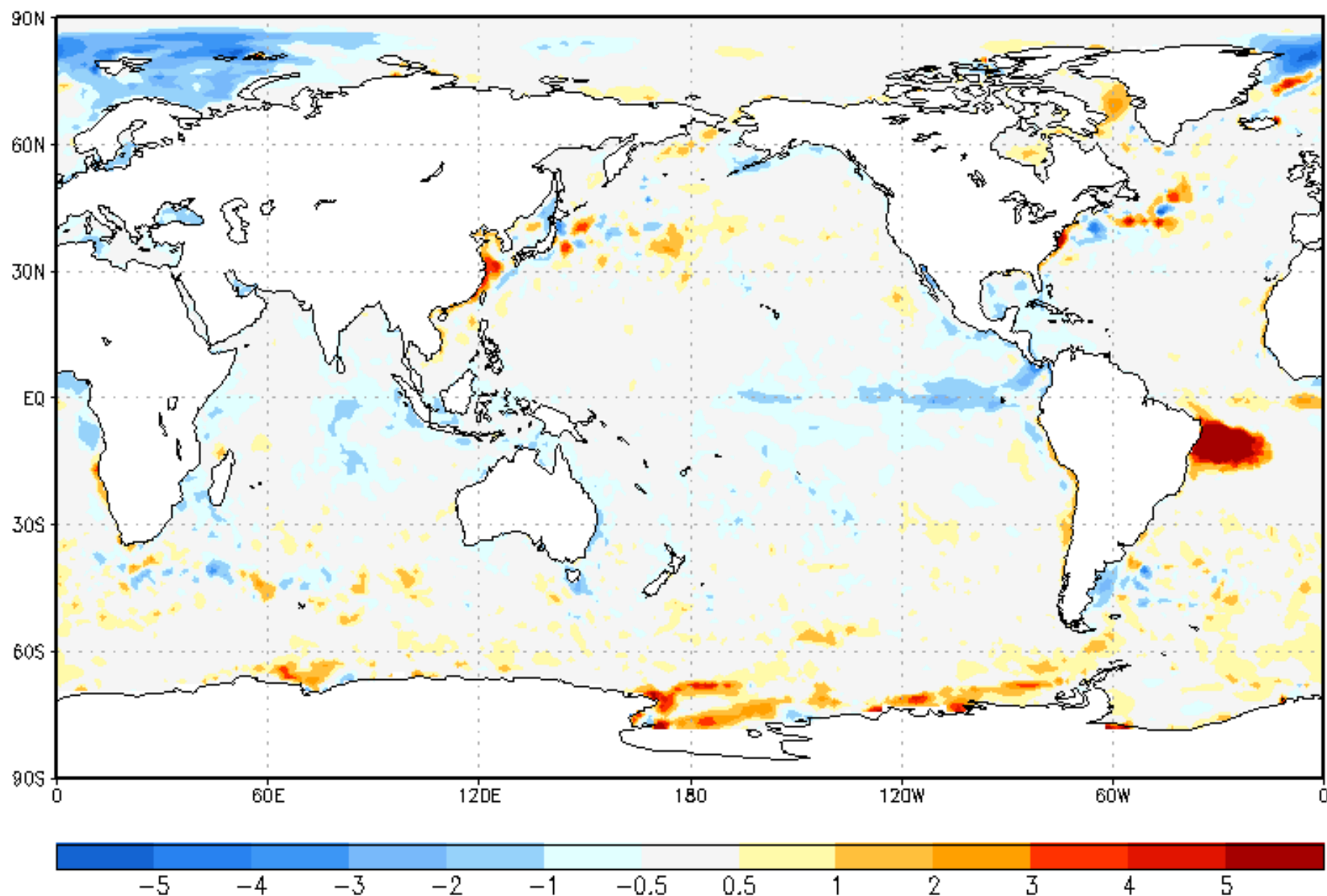
GrADS: COLA/IGES

2016-03-29-15:04

30 March 2016

16

New minus Old. 20160329 06Z fcst OCN SST for 201603






Background Science Material



- The cold spots in the CFSv2 appear in the equatorial zone both north and south of the equator. The increased resolution in the equatorial zone (0.25°) means the model is "eddy permitting" but not "eddy resolving". That part of the western Atlantic is particularly energetic. Therefore, the model produces a lot of eddies there that have no exact correspondence in the real world as observed by the profile data. As a consequence, the assimilation in that area produces noise rather than a correction and grows both spatially and temporally.
- An emergency fix is to re-initialize the CFSv2 by replacing the ocean initial states with those from an off-line GODAS, in which a weak relaxation to climatology (the NODC WOD09) has been introduced, to control the noise.
- The longer-range solution is to incorporate this weak relaxation to climatology (as described above) in the fully-coupled CFSv2. The system will need to be tested to see its response to a more energetic ocean due to hourly forcing, in place of the daily-averaged forcing present in the off-line GODAS. Experiments have to be conducted while changing the frequency of the assimilation cycle and estimates of background and observation errors.

A decorative border of stylized flowers in shades of pink and yellow, arranged in a corner pattern along the left and bottom edges of the slide.

Today is the 5th
anniversary of the
operational
implementation of
the CFSv2